

We Claim:

1. A portable manually operated batch operation device comprising:

a liquid source;

a generator producing an ozone containing gas;

apparatus for preventing liquid from entering the ozone generator;

a gas pumping system arranged for causing the ozone-containing gas to flow from the generator to a contact region;

a liquid passageway arranged for conducting liquid from the liquid source to the contact region, where ozone from the ozone-containing gas dissolves in the liquid;

a liquid pumping system arranged for causing the liquid to move through the liquid passageway from the liquid source to the contact region; a system for separating undissolved gas from the liquid and venting the gas; and

a system for preventing ozone in the separated gas from escaping into the atmosphere by passing the gas through an ozone reducing material before venting.

2. The device of claim 1 where a control system is arranged for operating the generator, the liquid passageway, the gas pumping system, and the liquid pumping system.

3. The device of claim 1 where the ozone containing gas is made by a corona discharge generator.

4. The device of claim 1 where the pumping system uses pump means to mix the ozone-containing gas with the liquid and recirculate the liquid being ozonated until it is dispensed from the device.

5. The device of claim 4 where the pump means includes a static mixer.

6. The device of claim 4 where the pump means is a positive pressure liquid pump.

7. The device of claim 4 where a second pump is used to dispense the ozonated liquid.

8. The device of claim 1 where the ozone containing gas is pumped by a gas pump through a diffuser into the liquid.

5 9. The device of claim 8 where the diffuser is that disclosed in U.S. Patents 5,422,043 and 5,858,283.

10. The device of claim 1 where more ozone is generated than can be dissolved in the liquid flow.

10 11. The device of claim 1 where the dissolved ozone concentration is determined by the solubility of ozone in the liquid.

12. The device of claim 1 where a valve controls the rate of output flow of the ozonated liquid through the dispensing tip.

13. The device of claim 12 where the excess portion of the ozonated liquid flow is recirculated to the contact region or reservoir.

15 14. The device of claim 13 where the output pressure is regulated by a relief valve in the recirculation line.

15. The device of claim 1 where the ozonated liquid is caused to pulsate as it leaves the outlet orifice.

20 16. The device of claim 15 where the pulsation is produced by the outputting pump.

17. The device of claim 15 where the pulsation is produced by a resonating structure in the liquid output line.

18. The device of claim 1 where porous hydrophobic material is used to prevent liquid from entering the ozone generator.

25 19. The device of claim 1 where the excess gas is separated from the liquid at minimal pressure.

20. The device of claim 1 where the excess gas is separated from the liquid by use of porous hydrophobic material.

10042473-010902

21. The device of claim 1, further including a system which prevents liquid from entering the ozone reducing material.

22. The device of claim 1 where an ozone sensor causes an indicator to show that the device is operating properly.

5 23. The device of claim 1 where the liquid source is a reservoir that can be temporarily removed for filling with liquid.

24. The device of claim 1 where bubbles of the ozone containing gas are displayed.

10 25. The device of claim 1 where the liquid source is a connection to a pressurized water supply controlled by a liquid level control valve.

26. The device of claim 1 where the air supplied to the ozone generator is dried by passage through a desiccant material.

15 27. The device of claim 26 where the desiccant material is protected from entry of moist air when the device is not operating by use of spring loaded check valves.

28. The device of claim 1 where the gas/liquid separating apparatus includes a float valve.

20 29. The device of claim 1 where the ozone producing and dissolving system and the liquid dispensing system are detachable from one another.

30. The device of claim 29 where the liquid dispensing system is responsive to the controller by means of an electrical connection.

25 31. The device of claim 1 where the liquid passageway extends to a dispensing tip and where the liquid pumping system is arranged to cause the liquid to move from the contact region to the dispensing tip.

32. The device of claim 21 where liquid is prevented from entering the ozone reducing material by use of a porous hydrophobic barrier.

20060705 10042473 0010000